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ABSTRACT

The present study investigated the effects of repetitions and questions (without feedback) at varying lags during self-paced learning from text. High school students read a series of unrelated paragraphs, each of which was repeated or tested after a variable lag. In a mixed condition, texts and repetitions of particular sentences were combined within paragraphs. Subjects were given free-recall and cued-recall tests one week later. In general, repetition did not improve performance. Correct answers to questions during the initial study task decreased as presentation-question lag increased. However, question-answering improved performance on the delayed tests substantially; the effect was constant over all lags studied. Question-answering produced better performance than repetition. Question-answering appeared to have operated primarily on memory traces of the information specifically tested. There was no evidence of any generalized attentional or strategy shifts or of any spread of effects to topically related information in memory. The effect of answering questions correctly appeared to have increased with increasing presentation-question lags. (Author)

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EFFECTS OF REPETITIONS AND QUESTIONS AT VARYING LAGS DURING SELF-PACED LEARNING FROM TEXT

Barbara Hayes-Roth

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ABSTRACT

The present study investigated the effects of repetitions and questions (without feedback) at varying lags during self-paced learning from text. High school students read a series of unrelated paragraphs, each of which was repeated or tested after a variable lag. In a mixed condition, tests and repetitions of particular sentences were combined within paragraphs. Subjects were given free-recall and cued-recall tests one week later. In general, repetition did not improve performance. Correct answers to questions during the initial study task decreased as presentation-question lag increased. However, question-answering improved performance on the delayed tests substantially; the effect was constant over all lags studied. Question-answering produced better performance than repetition. Question-answering appeared to have operated primarily on memory traces of the information specifically tested. There was no evidence of any generalized attentional or strategy shifts or of any spread of effects to topically related information in memory. The effect of answering questions correctly appeared to have increased with increasing presentation-question lags.

The selection and sequencing of adjunct aids can influence learning in important ways. The present study concerns the effects of two aids -- repetitions and questions (without feedback) -- used during self-paced learning from text. The following empirical and theoretical questions were investigated:

Does repetition improve retention of text and is the magnitude of the improvement dependent upon presentation-repetition lag? It is well known that repetition of to-be-learned information can improve retention and that the improvement can increase with lag. Such results have been obtained in various verbal learning paradigms (Bjork, 1970; Greeno, 1964; Hintzman, 1970; Landauer & Rubin, 1966; Melton, 1970; Peterson, Hilner & Saltzman, 1962; Peterson, Wampler & Kirkpatrick, 1963; Underwood, 1969, 1970) and in some studies of learning from text (Rothkopf & Coke, 1963, 1966). Hayes-Roth and Jongeward (1975), however, found no effects of repetition or lag on long-term retention (one-week retention interval) in either of two studies of self-paced learning from text.

Does question-answering improve retention of text and is the magnitude of the improvement dependent upon presentation-question lag? Many studies of verbal learning (Allen, Mahler, & Estes, 1969; Coke, 1971; Hogan & Kintsch, 1971; Lachman & Laughery, 1968; Tulving, 1967; Whitten, 1974; Whitten & Bjork, 1972) and learning from text (Anderson & Myrow, 1971; Bruning, 1968; Frase, 1968a, b; Hayes-Roth & Jongeward, 1975; McGaw & Grotelueschen, 1972; Rothkopf, 1966, 1971; Rothkopf & Bisbicos, 1967; Sones & Stroud, 1940; Spitzer, 1939) have demonstrated that tests can function as effective learning events. It is unclear what relationship should obtain between the effect of tests and presentation-test lag. As lag increases,

the number of questions answered correctly during study decreases. If the effect of answering a question correctly is constant over lag, the function relating final test performance to lag should decrease. It is possible, however, that the effect of answering a question correctly increases over lag (this possibility is discussed below). In that case, the opposition of the two factors could produce an increasing, decreasing, or constant function relating final test performance to lag. In fact, investigations of the relationship between the effects of tests and presentation-test lag have produced mixed results. Landauer and Eldridge (1967) found that, in their paired-associates learning task, the relationship between retention and lag varied over materials. Several studies of learning from text (Boyd, 1973; Frase, 1968a,b; Frase, Patrick & Schumer, 1970; Eichens, Gaite & Kumar, 1972; Sones & Stroud, 1940; Spitzer, 1939) have shown that retention decreased as lag increased. Hayes-Roth and Jongeward (1975) and Rothkopf & Coke (1963) found that retention increased as lag increased.

Which provide the greatest retention benefit: repetitions or questions? One possible interpretation of the effect of correctly answered questions is that they provide two distinct benefits: the benefit ordinarily obtained from simple repetition and the additional benefit of active retrieval. Even is this were true, however, the actual level of final test performance might be higher for repeated items than for questioned items. This follows from the fact that, while all repeated items receive the benefit of repetition, only correctly answered questions receive the combined benefits of repetition and active retrieval. Unless the benefit of active retrieval is quite substantial, the combined effects may not be sufficient to offset the decrease in number of items receiving the effects. In fact, comparisons of the effectiveness of repetitions and

tests have produced mixed results. Landauer and Eldridge (1967) observed, in their Experiment I, that tests improved retention as much as repetitions, at each of the two lags studied. La Porte and Voss (1975) also observed that immediate tests were as effective as immediate repetitions. Rothkopf and Coke (1963) observed that questions were more effective than repetitions in a mixed condition, while the reverse held when the two were not mixed. Hayes-Roth and Jongeward (1975) found that questions produced substantially better performance than repetitions at lags ranging from zero to twenty-nine intervening items. Sones and Stroud (1940) found that questions produced better retention than repetitions at one and three day lags, while the reverse held at fifteen and seventeen day lags.

What is the locus of the effect of answering questions without feedback? The beneficial effect of questions on retention of textual information has been attributed to three classes of factors. Most researchers agree that questions have content-specific effects (Frase & Schwartz, 1975; La Porte & Voss, 1975; Rothkopf, 1966; Rothkopf & Bisbicos, 1967; Rothkopf & Bloom, 1970), suggesting that questions function, at least in part, to strengthen memory representations of the information tested. Content-specific effects may be considered to reflect both repetition and retrieval effects, either of which may increase with lag. It has also been suggested that the presence of questions in learning materials induces "mathemagenic" activities that shape particular text inspection behaviors (Rothkopf, 1965, 1970). Finally, it has been suggested that test activities activate not only memory representations of the information necessary to answer test questions, but may also activate memory representations of topically related information, thereby strengthening representations of

both kinds of information (McGaw & Grotelueschen, 1972; Rothkopf & Billington, 1974).

What is the relationship between the effect of active retrieval and lag? Assuming that questions do provide an additional retrieval benefit, it is possible that the effect of active retrieval increases as lag increases. Several studies have shown that test items that are difficult for the subject (those least likely to be answered correctly) provide an increased retention benefit (Craik, 1970, Gotz & Jacoby, 1974; Madigan & McCabe, 1971; Whitten & Bjork, 1972). Corresponding studies of learning from text (see review by Anderson & Biddle, 1975) have shown that relatively difficult question forms, such as completion questions, improve retention more than simpler forms, such as multiple-choice questions. If lag is taken as a measure of question difficulty, then these results suggest that the effect of a correctly answered question should increase with lag.

Method

Subjects. Subjects were eighty-four high school students. Individual honoraria were contributed to a student fund.

Materials. The materials were sixteen ten-sentence passages, one on each of the following topics: aardwolves, absolutism, Sara Bernhardt, Chinese gardens, cotton, Martinique, memory defects, Nile River, porpoises, Beatrice Potter, psychosis, puppets, soaring, thunderstorms, urban climate, Toussaint. All of the passages were based on articles in the Encyclopedia Britannica (1974). Completion questions were constructed by deleting a portion of each sentence in each paragraph. The following is an example of the passage and completion questions for the topic "absolutism."

Absolutism is a theory of government.
It was practiced in Europe in the 15th-18th centuries.
Under absolutism, monarchs wanted unrestrained power.
The best example of absolute monarchy was France's
Louise XIV.
He was known as the Sun King.
He described his power by saying - "I am the state."
Monarchs said they were answerable only to God.
One consequence was to reduce the power of the churches.
Absolutism was ended by the Glorious Revolution in England.
In other countries, it lasted until the French Revolution.

Absolutism is _____.
It was practiced in Europe in the _____ centuries.
Under absolutism, monarchs wanted _____.
The best example of absolute monarchy was France's _____.
He was known as _____.
He described his power by saying _____.
Monarchs said they were answerable _____.
One consequence was to reduce the power of _____.
Absolutism was ended by _____ in England.
In other countries, it lasted until _____.

Design and Procedure. Subjects were assigned randomly to three groups. The Repetition Group worked with passages that were presented only once or repeated after a variable lag. The Question Group worked with passages that were presented only once or tested with completion questions (without feedback) after a variable lag. The Mixed Group worked with passages that were presented only once or followed by mixed questions and repetitions (half the sentences in each passage randomly assigned to each condition). In each group, two passages were presented only once and two were repeated and/or tested after a log of: zero, one, two, four, eight, or sixteen intervening ten-sentence passages. Four serial orderings of conditions were used for seven subjects each in each group. In each serial ordering, one replication of each condition occurred in each half of the sequence. Passages on thunderstorms and Chinese gardens were used as primacy and recency buffers. The other passages were assigned randomly to conditions for each subject.

Passages and repetition/test passages were typed one to a page in booklets. Subjects worked through the booklets at their own rates, studying the passages and repetitions and trying to answer questions. One week later, subjects worked through test booklets. First they wrote all they could remember from the passages, given only the topic names. Then they attempted to answer completion questions.

Results

Study-Phase Cued Recall. Proportions correct recall during study are plotted in Figure 1 for the Question Group and for questioned items in the Mixed Group. Proportion correct decreased over lag in both groups (Question Group: $F(5,27) = 27.50$, $p < .001$; Mixed Group: $F(5,27) = 6.86$, $p < .01$). The difference between proportions correct in the two groups was not statistically significant.

Test-Phase Free Recall. Figure 2 shows the proportion of sentences correctly recalled for the three groups. A sentence was scored correct if its gist appeared in the subject's recall protocol (Proportions for questioned and repeated items in the Mixed Group are plotted separately.) Performance for repeated items (pooled over all lags) was no better than performance for once-presented items in either the Repetition Group ($t(54) = 0$) or the Mixed Group ($t(27) = 1.43$, $p < .1$). Questions produced better performance than once-presented items in both the Question Group ($t(54) = 5.33$, $p < .001$) and the Mixed Group ($t(27) = 6.00$, $p < .001$). Questions produced better performance than repetitions in both the between groups (Question versus Repetition Groups) comparison ($t(54) = 3.01$, $p < .01$) and the within group (Mixed Group) comparison ($t(27) = 6.32$, $p < .001$). There were no significant differences between performance in the Question Group

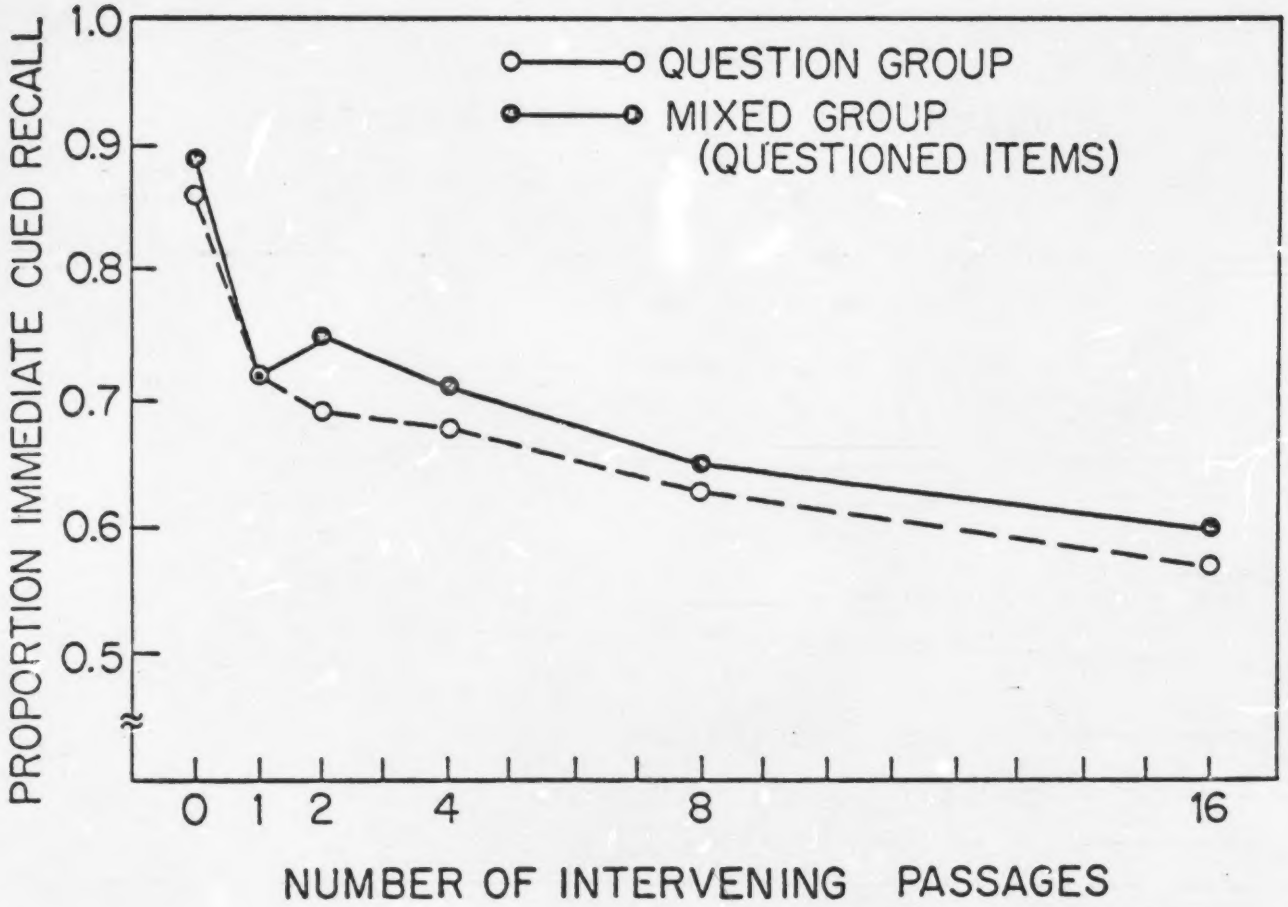

Figure 1. Proportion correct immediate cued recall as a function of lag.

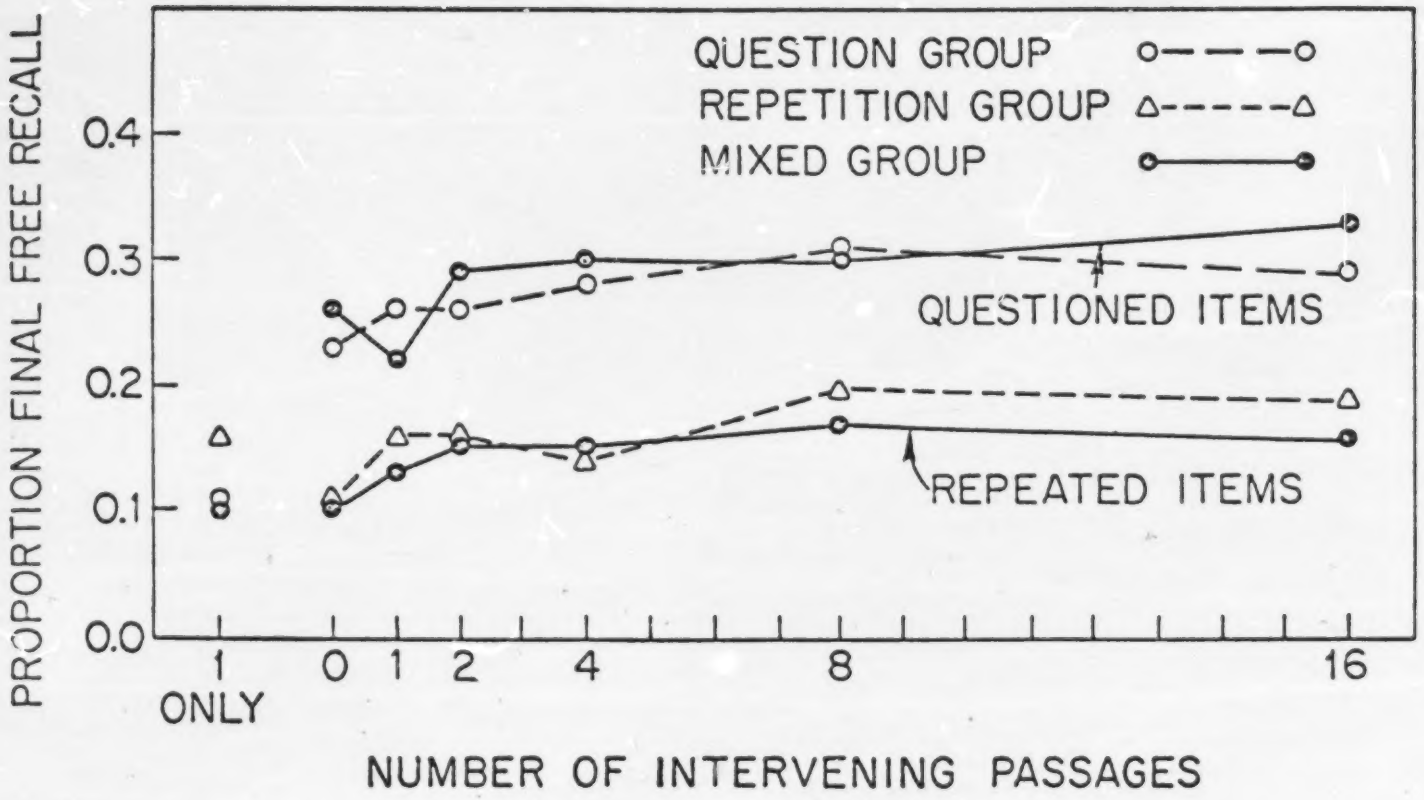

Figure 2. Proportion correct final free recall as a function of lag.

and performance on questioned items in the Mixed Group or between performance in the Repetition Group and performance on repeated items in the Mixed Group. There were no significant differences among the three groups regarding performance on the once-presented items. There were no significant lag effects in any of the three groups and no significant interactions.

Test-Phase Cued Recall. Figure 3 shows the proportions correct cued recall for the three groups. (Proportions for questioned and repeated items in the Mixed Group are plotted separately.) Performance for repeated items (pooled over all lags) was no better than performance for once-presented items in the Repetition Group ($t(54) = 1.39$, $p < .1$) but is was significantly better ($t(27) = 2.75$, $p < .01$) in the Mixed Group. Questions produced better performance than once-presented items in both the Question Group ($t(54) = 5.38$, $p < .001$) and the Mixed Group ($t(27) = 7.75$, $p < .001$). Questions produced better performance than repetitions in both the between groups (Question versus Repetition Groups) comparison ($t(54) = 3.56$, $p < .001$) and the within-group (Mixed Group) comparison ($t(27) = 5.20$, $p < .001$). There were no significant differences between performance in the Question Group and performance on questioned items in the Mixed Group or between performance in the Repetition Group and performance on repeated items in the Mixed Group. There were no significant differences among the three groups regarding performance on the once-presented items. There were no significant lag effects in any of the three groups and no significant interactions.

Discussion

The present experiment produced comparable results for both the free-

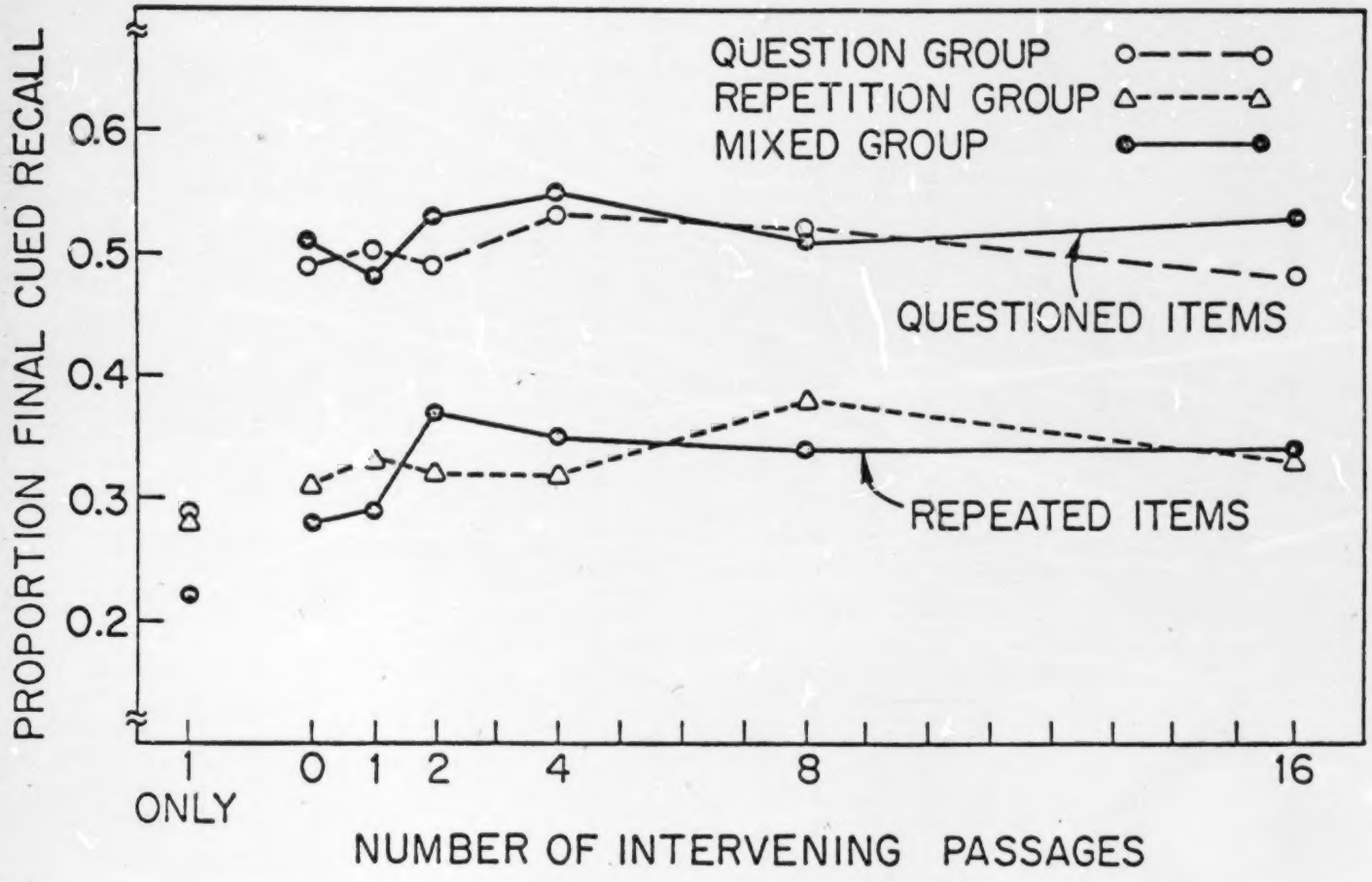

Figure 3. Proportion correct final cued recall as a function of lag.

recall and cued-recall tests. The only difference between the two was that overall performance was lower on the free-recall test. Therefore, no distinctions will be made between the two tests in the following reconsideration of the empirical and theoretical questions introduced above.

Does repetition improve retention of text and is the magnitude of the improvement dependent upon lag? The present results provide little evidence for improvement in retention produced by repetition of text, and no evidence for differential effects of repetitions at varying presentation-repetition lags. These results are surprising, in light of the large body of verbal learning research supporting the assumptions that repetition improves retention and that the improvement increases with lag. Hayes-Roth and Jongeward (1975), however, obtained comparable results in two similar experiments. Of course, there may have been effects of repetititions that went undetected in this experiment. If so, however, the effects were very small. These results suggest that repetition of text at lags of up to sixteen intervening passages, in a self-paced study condition, does not facilitate long-term retention.

Does question answering improve retention of text and is the magnitude of the improvement dependent upon lag? Question-answering provided a substantial improvement in retention in the present experiment, comparable to results obtained in previous studies. Proportion recalled was not influenced by lag, as might be expected, given the mixed results of previous experiments. This result does not, however, imply that the effect of answering a question correctly does not increase with lag, as discussed below.

What is the locus of the effect of answering questions without feedback? The present results provide strong support for the hypothesis that question answering functions to strengthen memory traces representing the information specifically tested. The results provide no evidence that the presence of questions induces more efficient text inspection behaviors or that question-answering activities strengthen representations of topically related information in memory. Two comparisons bear on these conclusions. First, there were no differences among the three groups regarding performance on the once-presented items. If subjects' text-inspection behaviors had been altered, performance on once-presented items should have been correlated with performance on the repeated/tested items. Second, performance on the questioned and repeated items in the Mixed Group was comparable to performance in the Question and Repetition Groups, respectively. If either text-inspection behaviors had been altered or topically related information in memory had been strengthened, performance on the repeated items in the Mixed Group should have been elevated, compared to performance in the Repetition Group.

Which provide the greatest retention benefit: repetitions or questions? The present results show a substantially greater benefit of question-answering, compared to repetition, in both the between and within groups comparisons. These comparisons provide strong evidence in favor of the hypothesis that question-answering provides some source of facilitation (presumably active retrieval) other than simple repetition. The comparison is actually biased against the hypothesis, because, while all repetitions occur, some questions are not answered correctly during study, particularly at longer lags. Questions that are not answered correctly provide neither the benefit of repetition nor the benefit of active retrieval. The fact

that question-answering provides some benefit beyond simple repetition, but that this additional benefit must be substantial in order to offset the decrease in the number of items receiving the effects.

What is the relationship between the effect of active retrieval and lag? Although final test performance on questioned items does not vary over lag, it does not follow that the effect of answering a question correctly does not vary over lag. The number of questions answered correctly during study decreased dramatically as lag increased. This means that even if the effect of a correct retrieval increases over increasing lag, that effect might be outweighed by the decreasing number of items that receive the effect. It is quite possible that the net result of these opposing factors might be the flat function obtained or even a decreasing function. It is also inappropriate to evaluate the relationship between the effect of a correctly answered question and lag by means of a conditional analysis (that is, by determining whether the probability of a correct response on the final test, given a correct response on the corresponding study question, increases with lag). It may be that questions answered correctly after long lags are easier, on the average, than questions answered correctly after short lags. This would bias a conditional analysis in favor of the hypothesis that the effect of a correctly answered question increases with lag. It is possible, however, to evaluate the hypothesis by simultaneously considering the functions relating final test performance to lag in the Repetition and Question Groups (or for the repeated and questioned items in the Mixed Group). The reasoning is as follows. In the Repetition Group, at each successive lag, a higher proportion of a fixed number of repeated items is recalled. In the Question Group, on the other hand, because of the decrease in number of

items correctly recalled (during study) over lag, the effect of answering questions correctly must operate on a decreasing number of items over lag. If the effect of a correct retrieval is constant over lag, then the slope of the function relating final test performance to lag in the Question Group must be less than the slope of the corresponding function in the Repetition Group. If the slope of the Question Group function is no less than the slope of the Repetition Group function, then it must be that the effect of active retrieval increases with lag. In fact, all relevant comparisons in the present experiment indicated that the slope of the lag function for questioned items was no less than the slope of the lag function for repeated items. Of course, the apparent absence of a difference is weak evidence at best. However, within the constraints of this kind of argument, it appears that the effect of active retrieval increases over increasing lags.

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